The habitat within Hilton Creek has been classified as conducive to steelhead spawning and rearing, but steelhead utilization is limited by intermittent flows and several passage impediments. The measures discussed below were developed to enhance conditions in Hilton Creek and increase steelhead utilization by improving access to spawning and rearing habitat. The actions are focused on the lower reach of the creek, which is situated on Reclamation property, and include the following:

- augmenting streamflow in Hilton Creek through the use of a supplemental watering system to release water for flow-related enhancement;
- increasing rearing habitat by constructing a channel extension at the lower end of Hilton Creek;
- improving fish passage past migration impediments; and
- enhancing habitat within the existing channel of Hilton Creek at selected locations.

In addition, fish rescue activities may be necessary in lower Hilton Creek during drought conditions. A protocol for identifying when a rescue would occur and the methods to be employed is also discussed.

3.1 SUPPLEMENTAL WATERING SYSTEM

As previously discussed, streamflow in Hilton Creek is intermittent, and the objective of the supplemental water system is to provide a dependable year-round source of cool water to allow the fish to survive the summer months until natural flow resumes in the winter. Construction of the supplemental watering system was completed in the fall of 1999, and the system is presently being used to support the current young-of-the-year. The details of the supplemental watering system are provided below.

3.1.1 INFRASTRUCTURE

The system is comprised of a pipeline with two release locations in Hilton Creek and one release location in the Stilling Basin (Figure 3-1). An energy dissipation/aeration structure has been constructed at each release point in order to maintain dissolved oxygen concentrations near the saturation point. Presently, water is delivered from Lake Cachuma to the release points via gravity flow through a fixed intake along Bradbury Dam. The system was designed to have a total capacity to 10 cubic-feet-per-section (cfs) with all three release points operating, and a capacity to deliver 8.85 cfs to Hilton Creek with the upper and lower release points operating. The existing infrastructure (distribution pipeline) of the watering system is being repaired to increase the capacity

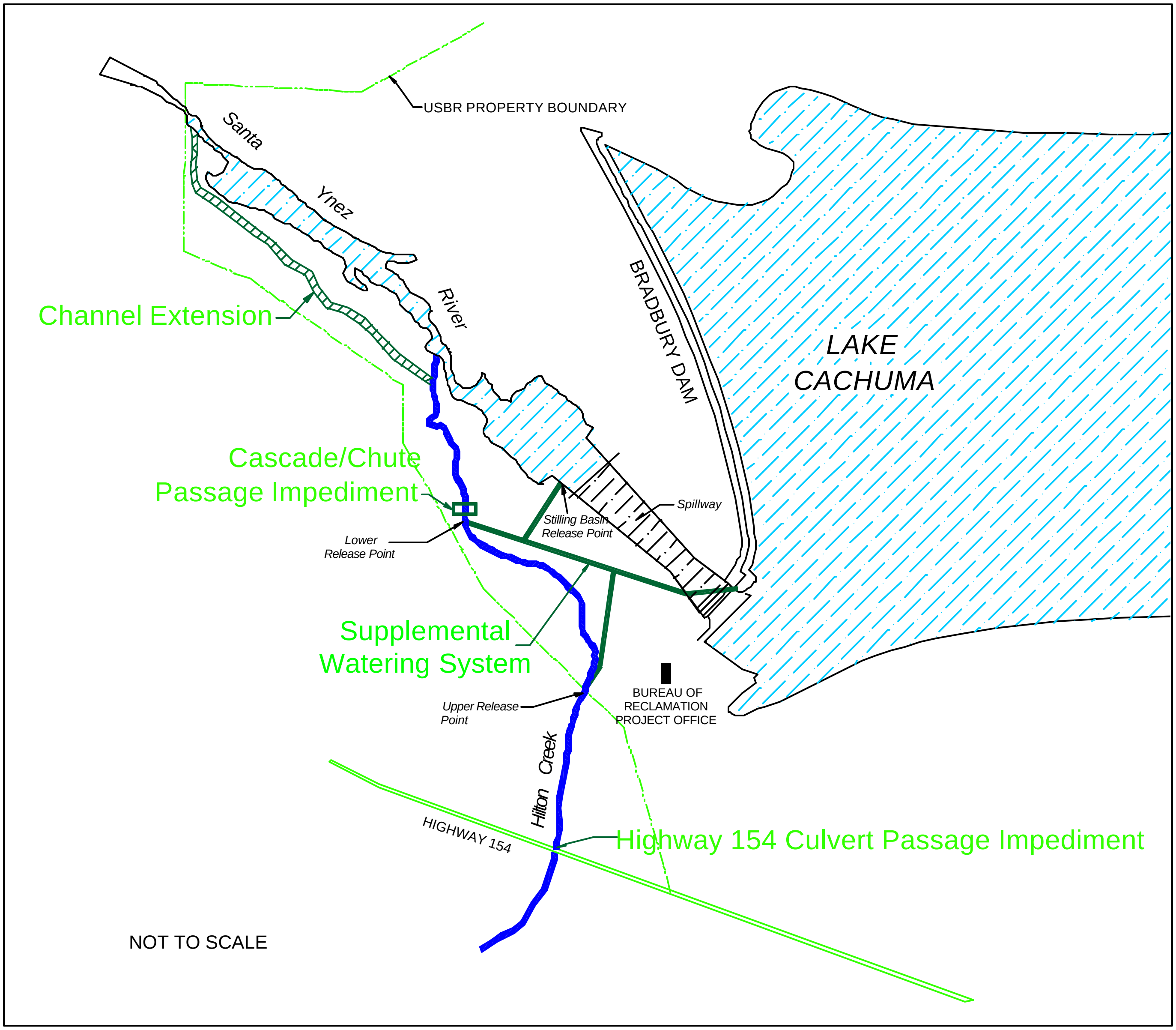

Figure 3-1 Hilton Creek Enhancement Project

of the system (currently below the anticipated level), and additional portions of the infrastructure (pump and flexible intake) will be added in the next two years. These enhancements to the water delivery system, which will enable the system to deliver water via gravity feed or pumping, are presently being designed. If these upgrades require turning off the flow of water into Hilton Creek and/or the mainstem, then Reclamation will need to reinitiate consultation with NMFS.

The facility will operate by gravity flow or pumped flow depending on flow targets and lake surface elevation. The capacity of the permanent watering system will vary with lake level because of the gravity fed system. When the pump is in use, the main pump will run off the local electricity supply. A secondary, fuel-powered pump will be located on site in the event of a problem with the existing pumping system (*e.g.*, a power outage or maintenance). Having both the gravity-flow and pump systems will ensure consistent water deliveries to Hilton Creek.

Rainbow trout/steelhead require cool water. Lake Cachuma is thermally stratified during spring and summer, with warm water near the surface (the epilimnion layer) and cold water at deeper levels (the hypolimnion). Vertical thermal profiles measured during the summer indicate that water should be obtained from a minimum depth of 65 feet (20 meters) below the lake's surface in order to obtain water measuring 18°C or cooler (SYRTAC 1997). A variable intake line (snorkel) to regulate the depth from which water in Lake Cachuma is drawn will also be installed.

3.1.2 OPERATIONS

Supplemental water releases into Hilton Creek will be made to maintain flows generally between 2 and 5 cfs depending on the water year type, natural flow in Hilton Creek, and the amount of water stored in the lake. A 2 cfs minimum flow in Hilton Creek will be maintained once the pump system is installed thus creating the ability to water the lower reach in 98% of years (NMFS 2000).

The reservoir releases for fish enhancement, especially mainstem target flow releases (see *Appendix B - Flow Related Fish Enhancement*), will be made via the Hilton Creek supplemental facility. Mainstem target flows will be established in all years except critical drought years. During drought situations, when the elevation of Lake Cachuma declines below 665 feet (2% of years), the watering system will not be able to deliver water to Hilton Creek. Migrating steelhead, however, are not expected to reach Hilton Creek in drought years. When such a situation occurs, a fish rescue will likely be performed in Hilton Creek assuming any steelhead spawned there that year. The decision to conduct a fish rescue will be made in consultation with NMFS and CDFG.

The Hilton Creek water delivery system was designed, and will be operated, to meet temperature and dissolved oxygen criteria appropriate for rainbow trout/steelhead. The two release points in Hilton Creek (upper site at the Reclamation property boundary and lower site in the chute) provide greater flexibility in adjusting the amount of water delivered to the different reaches of the creek. During operation of the temporary watering system in 1997, where water deliveries were made at the lower release point, water quality conditions were suitable throughout lower Hilton Creek. Water released at the upper release point could experience greater warming as it travels through the channel, or it may temporarily go subsurface at the open alluvial area before rising again at the bedrock chute. If this is a problem, releases could be shifted to the lower release point. Monitoring of water temperature, flows, and dissolved oxygen will be conducted in order to adjust operations of the two release points as necessary.

Further study of the conditions within Hilton Creek and the operation of the watering system will be needed to develop specific release scenarios for this system. Therefore, releases from the supplemental facility will be adaptively managed within the capability of the system. The releases to Hilton Creek within and among years will be managed by the Adaptive Management Committee. This committee is composed of a representative from Reclamation, the Cachuma Conservation Release Board, Santa Ynez River Water Conservation District (SYRWCD) Improvement District #1, SYRWCD, National Marine Fisheries Service (NMFS), and California Department of Fish and Game (CDFG). The Adaptive Management Committee may decide to modify the 2 cfs minimum flow required by NMFS once the pump is installed (NMFS 2000), although the decision must be approved by NMFS. Data to determine the flow versus habitat quantity in lower Hilton Creek will be collected to assist in system evaluations.

It is anticipated that releases will be primarily made through the upper release point in Hilton Creek to provide water supplementation to the longest portion of channel. In years when there are larger quantities of water to be released to meet the mainstem target flows, it is anticipated that a portion will be released through the Hilton Creek system into the Stilling Basin to enhance mainstem habitat between the release point and the confluence with Hilton Creek. Management of both the distribution of water among the three release points and the amount of water to be released will be based on a number of factors including, but not limited to, presence of spawning adult rainbow trout/steelhead, presence of rearing juveniles, reservoir storage, downstream water rights releases, water quality in Hilton Creek (*e.g.*, temperature), water losses, water temperature at the intake depth in Lake Cachuma, and natural flow in the system.

A ramping schedule will be used in Hilton Creek to protect rainbow trout/steelhead. The ramping schedule is shown in Table 3-1. During the first year of releases, managed flow changes will be made during daylight hours, and the creek will be monitored for potential stranding during ramping events.

Table 3-1 Hilton Creek Ramping Schedule

Release Rate (cfs)	Maximum Ramping Increment (cfs)	Minimum Ramping Frequency
10 to 5	1	4 hours
Less than 5 cfs	0.5	4 hours

3.2 CHANNEL EXTENSION

The objective of the proposed channel extension is to enhance the benefits of the supplemental water supply by creating additional steelhead rearing habitat in Hilton Creek. Four extension alternatives were considered and evaluated based on various hydrologic, habitat, and feasibility factors. Of these four alternatives, extension Alignment B was selected as the preferred alternative by the Hilton Creek Work Group, a subgroup of the SYRTAC. Further studies are required to determine the feasibility of this alignment in relation to such factors as seepage loss, water temperature, stream gradient, and predation.

The four alignment alternatives that were considered are shown in Figure 3-2, and consist of the following:

- Alignment A – consists of an alluvial floodplain which would provide an increase in net channel length of 596 feet.
- Alignment B – consists of a relic stream channel which would provide an increase in net channel length of 1,215 feet.
- Existing Alignment – represents the "no action" alternative.
- Former Alignment – consists of the former Hilton Creek alignment which discharged to the Stilling Basin. This alignment would decrease the net channel length by 145 feet.

The extension alignment selection criteria are summarized in Table 3-2, and a discussion of the criteria and project design considerations is presented below.

3.2.1 HYDROLOGIC CRITERIA

Since the water available for supplemental releases is limited, the most significant hydrologic concern regarding the proposed extension was potential seepage loss. In order to address this concern, piezometers were installed and groundwater elevations were monitored along Alignment A and Alignment B (Figure 3-2), and an infiltration study was performed along each of the alignments. The groundwater monitoring data and results of the infiltration study are presented below.

3.2.1.1 Groundwater Monitoring

In order to gain further understanding of the groundwater hydrology in the lower reach of Hilton Creek, seven piezometers were installed along Alignment A, and five piezometers were installed along Alignment B in February 1999.

The piezometers were installed using a backhoe, and are constructed of 4-inch diameter blank and .020-inch slotted Schedule 40 PVC pipe. The piezometers were installed to the greatest possible depth at each location, which was determined by the structural stability of the encountered sediment and/or the limitations of the backhoe. The piezometers are generally situated at depths between .5

Table 3-2 Hilton Creek Channel Extension Alternative Assessment Matrix

Criteria	Alignment A (Close to SYR)	Alignment B (Along base of bluff)	Existing Alignment (No Extension)	Former Alignment
Net Change in Channel Length[1]	+ 596 feet	+ 1,215 feet	No change	- 145 feet
Channel Gradient (% Slope)[2]	0.91%	1.1%	3.5%	3.9%
Estimated Water Loss Potential:	High	Low-Moderate	Low	Low
Infiltration Rate (gal/sec· ft^2)*	0.159	0.034 gal/sec· ft^2	unable to measure because water in creek	0.013 gal/sec· ft^2
Soil Type	Alluvium (gravel/cobble)	Predominantly colluvium (silt/sand/gravel)	Alluvium (gravel/cobble)	Alluvium (gravel/cobble)
Thermal Heating Potential	High • long channel • poor canopy cover	Moderate • longest channel • good canopy cover	Moderate • medium channel • fair canopy cover	Low • short channel • good canopy cover
Projected Rearing[3] **Habitat Quality**	Moderate quality habitat	High quality habitat	High quality habitat	Moderate quality habitat
Projected Spawning[3] **Habitat Quality**	Moderate – High	Moderate – High	Moderate – High	Low
Habitat for Other[3] **Fish Species**	Only sculpin currently use Hilton Creek. By designing the entrance to the channel with a moderate gradient, we can keep out predatory fish. CA red-legged frogs, western pond turtles and two striped garter snakes may find the extension to be good habitat.			
Avian Predation Potential	High • poor canopy • poor instream shelter	High • good canopy, good instream shelter, blue heron rookery	Low • fair canopy • good instream shelter	Low • good canopy • good instream shelter
Existing Riparian Zone	One side of channel has riparian zone	Well developed	Well developed in places, exposed in other places	Well developed

Criteria	Alignment A (Close to SYR)	Alignment B (Along base of bluff)	Existing Alignment (No Extension)	Former Alignment
Flow Control Structure Needed?	The “existing alignment” is considered the ‘no action’ alternative, and therefore that alignment will not require a flow control structure. If we choose to build an extension, whatever extension channel we select will require a flow control structure and an associated overflow channel (which will not require a structure).			
Fish Stranding Potential	Fish stranding potential is low since the watering system will provide year-round watered habitat except in dry years. Lower seepage rates along alignment B will help maintain water in the extension and therefore help reduce fish stranding.			
Potential for Flood Damage	High • near SYR • entrance aligned with river course	Low • along bluff at edge of flood plain	High • close to SYR	High • outlet in Stilling Basin • aligned w/ SYR
Long-Term Maintenance[4]	High • long channel • repair road crossings • storms can easily shift course	Moderate • long channel • repair road crossings	None	Moderate • short channel • storms can easily shift course
Additional Expenses[5]	• channel lining (most of length) • channel excavation • road crossing (1) • pipeline crossing	• channel lining (downstream[D/S] connection to SYR) • channel excavation • road crossings (2) • pipeline crossing	None	• remove debris jam • pipeline crossing
Construction Cost[6]	High	High	None	Low

[1]Relative to the length of the existing alignment
[2]Channel gradient was determined by subtracting the thalweg elevation at the confluence of the alignment with the SYR from the thalweg elevation at the outlet of the canyon (*i.e.*, the top of the old alignment) and dividing this value by length of the alignment.
[3]High quality habitat is possible in whichever alignment is selected provided that we design and construct it. The anticipated cost of this construction and its permanence varies between alignments.
[4]Long-term maintenance includes dealing with infilling of pools, riparian overgrowth, accumulation of woody debris, and the like. The effort and cost of these types of maintenance are relative to the channel length. Any structures listed under ‘additional expenses’ will also have to be maintained as well as the flow control structure.
[5]Includes structures required on only one alignment
[6]The ‘additional expenses’ make alignments A and B more expensive.
*Additional infiltration measurements will be taken in summer and fall because infiltration rates vary with the degree of saturation of the basin.

Assumptions: Assumes water in the creek year round (either from natural flows or the watering system)
“Existing alignment” represents the ‘no action’ alternative (*i.e.*, there are no improvements to this habitat, it is allowed to exist as is).
The channel extension is designed primarily to provide over-summering habitat and not spawning habitat (available upstream in Hilton Creek), therefore the channel design will not focus on spawning habitat.

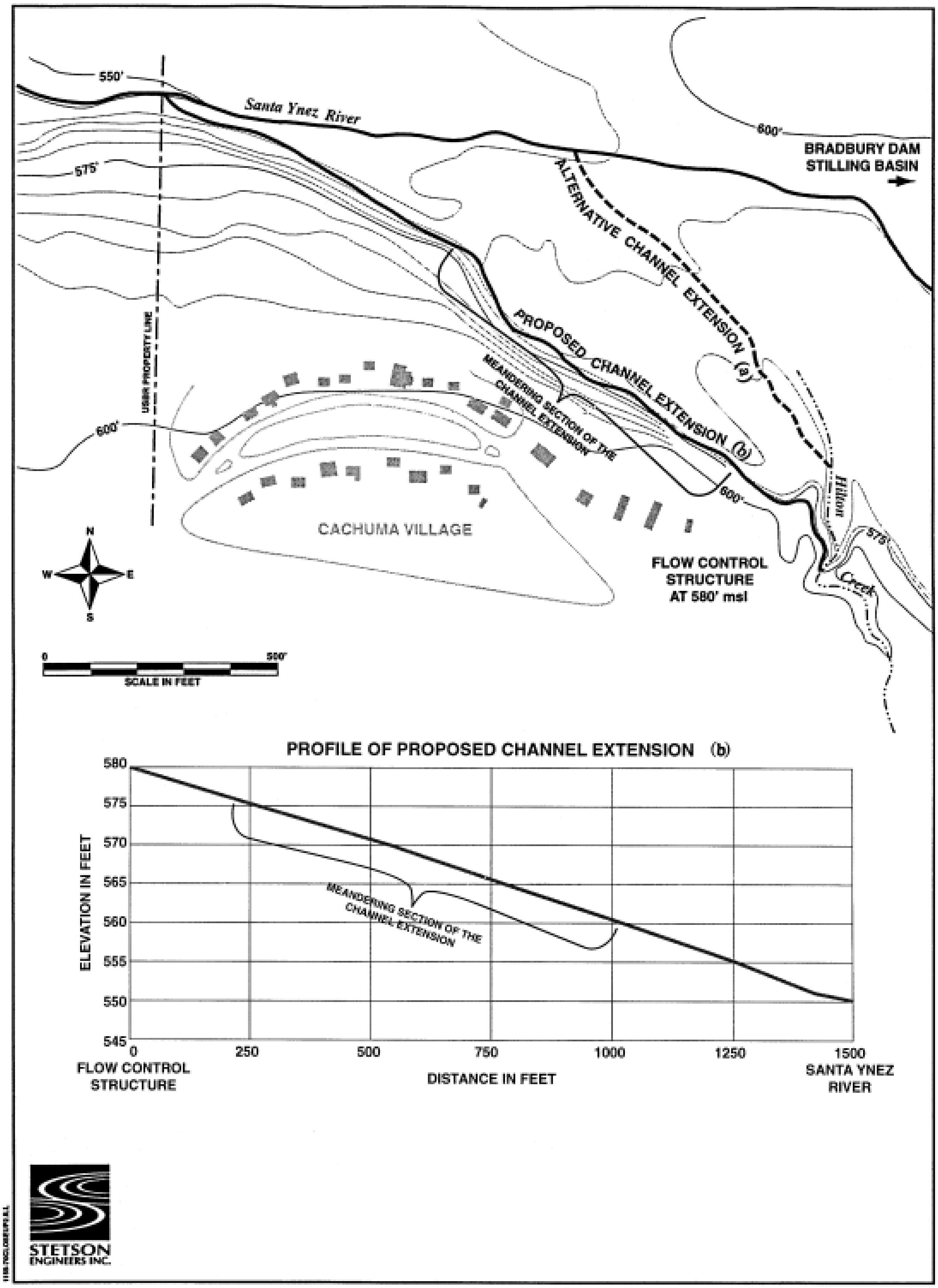

Figure 3-2 Alignment Options for Hilton Creek

and 2 feet below the groundwater table as sediment sloughing prevented installation at greater depths. The lithology encountered during installation of the piezometers generally consisted of sand, gravel, and cobble material along Alignment A, and silt, sand, and gravel along Alignment B. Groundwater was encountered at all locations except for PZ-B (SYRTAC 2000a, 2000b).

Groundwater elevation measurements have been collected monthly from the piezometers to aid in determining the proximity of groundwater to the surface, seasonal fluctuations in the groundwater table, and the groundwater flow direction gradient. Based on the data collected to date (SYRTAC 2000a), depth to groundwater below ground surface is greater along Alignment B as compared to Alignment A, and groundwater levels appear to be highest in the spring with fluctuations up to greater than 4 feet at some locations. The groundwater flow direction in the vicinity of Hilton Creek is toward the northwest and turns toward the west in the vicinity of the Long Pool.

3.2.1.2 Infiltration Rate Study

In order to estimate relative seepage loss along Alignments A and B and the former channel, an infiltration study was performed in March 2000. Data was not collected along the existing channel since there was approximately 7 cfs of surface flow in the creek. The infiltration study results indicate that the relative infiltration rates were highest along Alignment A, followed by Alignment B and the Former Alignment, respectively (SYRTAC 2000b).

In order to obtain data which is representative of the entire length of each alignment, the study was conducted at one location along the former alignment and three locations along Alignment A and Alignment B. At each test location, three bottomless 5-gallon buckets were situated 10 feet apart along the alignment thalweg, except at test location 1A along Alignment B at which only one bucket was used due to dense vegetation. The bottomless buckets were carefully pressed approximately 2 to 3 inches below ground surface. These buckets were filled with water, and the incremental drop in water level within the bottomless bucket was recorded per unit of time until the water level passed below ground surface. The infiltration rate for each test location was determined by averaging the infiltration rates of the three bottomless buckets, and the infiltration rate for each alignment was calculated by averaging the average rates at each test location.

The study results indicate that the relative infiltration rate is highest along Alignment A (.159 gallons/second-square foot) followed by Alignment B (.034 gallons/second-square foot) and the Former Alignment (.013 gallons/second-square foot), respectively. The results are presented in units of gallons per second per square foot (gallons/second-square foot) since the incremental drop in water level is applicable to the unit area of the bottomless bucket.

3.2.2 HABITAT CRITERIA

The habitat selection criteria included an evaluation of the stream gradient, potential quality of spawning and rearing habitat, thermal heating potential, avian predation potential, and the quality of the existing riparian zone.

The stream gradient for each alignment was determined by subtracting the thalweg elevation at the confluence of the alignment with the Santa Ynez River from the thalweg elevation at the outlet of the bedrock canyon (*i.e*., the top of the old alignment) and dividing this value by the length of the alignment. The calculations did not account for variations in topography between the two elevations. Based on these calculations, the highest stream gradient was along the former alignment at 3.9% and was followed by the existing alignment at 3.5%, Alignment B at 1.1%, and Alignment A at .91%.

For the other categories, a qualitative descriptor was assigned to each alignment based on an assessment of the area by SYRTAC biologists and hydrologists. The evaluation is based on current conditions and an estimate of future conditions with year-round streamflow. The results of the habitat evaluation are as follows.

- Alignment A has a high thermal heating potential due to the channel width and the lack of mature trees and vegetation. Consistent streamflow likely would support willows and the long-term development of mature riparian vegetation. Potential rearing habitat was ranked of moderate quality due to the projected lack of instream cover and structure for pool development. Potential spawning habitat was ranked moderate to high quality due to the present substrate. The lack of riparian and instream cover suggested a high avian predation potential. Currently, a riparian zone exists on only one side of the proposed channel alignment.

- Alignment B has a moderate thermal heating potential based on the high degree of shading provided by the canopy of dense riparian vegetation and mature sycamore trees and the adjacent bluff. Projected instream complexity and cover suggest high quality potential rearing habitat, while gravel and sand substrate suggest moderate to high quality potential spawning habitat. Dense canopy cover suggests low to moderate avian predation potential, although it was noted that the trees adjacent to the proposed alignment support a heron rookery.

- The Existing Alignment, evaluated on existing conditions, has a moderate thermal heating potential, high quality potential rearing habitat, moderate to high quality potential spawning habitat, a low avian predation potential, and areas of well-developed riparian zones.

- The Former Alignment has a low thermal heating potential due to existing canopy cover, moderate-quality potential rearing habitat, low-quality potential spawning habitat, a low avian predation potential, and a well-developed riparian zone.

3.2.3 Feasibility Criteria

The feasibility criteria included an evaluation of the necessity of a flow control structure, the potential for flood damage, long-term maintenance, additional expenses, and the construction cost. These criteria were evaluated by SYRTAC working group hydrologists, engineers and biologists. The assigned qualitative descriptors are as follows:

- Alignment A would require a flow structure and an associated overflow channel (see design considerations below). It has a high potential for flood damage due to its proximity to the mainstem Santa Ynez River. This higher potential for flood damage suggests that long-term maintenance costs would be higher than for the other alignments. Projected construction costs would also be high due to required channel engineering and grading, protection of road and pipeline crossings and potential channel lining materials.

- Alignment B would require a flow structure and an associated overflow channel (see design considerations below). It has a low potential for flood damage as it is further from the mainstem and partially protected by the mature riparian zone. Similarly, associated long-term maintenance costs are projected to be moderate. Projected construction costs would also be high due to required channel engineering and grading, protection of road and pipeline crossings and potential channel lining materials.

- The Existing Alignment would not require a flow structure and has a high potential for flood damage due to its proximity to the Santa Ynez River.

- The Former Alignment would require a flow structure and an associated overflow channel. It has a high potential for flood damage. Construction and long-term maintenance costs are projected to be moderate, limited primarily to debris removal and minor grading.

3.2.4 Project Design Considerations

Since the objective of the extension project is to create additional rearing habitat, the extension will be designed as a low-flow channel. The channel will be designed to accommodate flows up to 15 cfs, but operating flows are anticipated to be less than 5 cfs. As part of the design, the existing channel would continue to serve as an overflow channel to convey water during large rainstorm events, and it is anticipated that both the channel extension and the existing channel would serve as migration corridors for adult rainbow trout/steelhead during high-flow events.

In order to regulate flows into the channel extension, flow control structures will need to be included in the design. Structures such as a submerged boulder weir could be used to direct flow into the channel extension during low flows, and a limiter log structure could be used to prevent high flows from entering the extension.

Habitat improvements may also be included in the project design. Materials such as boulders, woody debris, suitable gravel, and vegetation could be used to create high value fish habitat. Riparian vegetation including willow cuttings, cottonwood, oak, and sycamore could be planted along the channel to provide shading and reduce increases in water temperature, and a temporary irrigation may need to be installed to establish the plantings.

The channel extension would be monitored to assess its performance and determine the need for any maintenance. Following a high-flow year, it may be necessary to repair the channel where it meets the Santa Ynez River. Sediment transport through the channel extension is expected to be minimal, since high flows would be diverted to the current Hilton Creek channel. Habitat monitoring will be used to decide whether sediment supplementation or removal would be necessary. The success of riparian plantings would also be assessed and corrective measures taken as needed.

3.3 FISH PASSAGE IMPROVEMENT PROJECTS

The objective of the Hilton Creek fish passage improvement project is to improve fish passage through two identified migration impediments so that the steelhead can utilize upstream spawning and rearing habitat. The lower migration impediment consists of a steep 6-foot cascade and 140-foot long confined bedrock chute located approximately 1,380 feet upstream of the confluence with the mainstem. Above this impediment there is a complete passage barrier at the Highway 154 Culvert. The SYRTAC project biologist has never observed steelhead in the reach upstream of the chute pool to the Reclamation property boundary although fish have been observed in the pool directly downstream from the Highway 154 Culvert. Providing passage through the cascade and bedrock chute will give access to approximately 2,800 feet of stream channel up to the culvert at the Highway 154 crossing, and providing access through the culvert will give access to additional upstream habitat. The fish passage improvements to allow better access through the cascade and bedrock chute are scheduled to be constructed in the 2001, and the preliminary design to modify the Highway 154 Culvert is presently being completed.

3.3.1 CASCADE AND BEDROCK CHUTE

Since it is not known whether the impediment to migration is due to the height of the cascade or the high-flow velocity in the bedrock chute, this project concentrates on modifying the hydraulic conditions at both of these impediments. Additionally, the project focuses only on improving passage upstream of the plunge pool since adult steelhead have been observed in this pool.

The design involves creating a backwater effect in the plunge pool, modifying the streambed near the crest of the cascade, and constructing two cast-in-place concrete channel obstructions (or roughness elements) and five boulder-sized cast-in-place concrete elements in the bedrock chute area. Collectively, these actions will reduce the effective height of the cascade and lower velocities in the bedrock chute. This design is expected to provide acceptable adult steelhead passage at streamflows above 5 cfs with increased effectiveness at flows above 10 cfs. The uppermost streamflow at which passage can be expected will need to be determined from field observations.

3.3.1.1 Project Background

The conceptual plan for the fish passage project as presented in the approved grant proposal for the *Enhancement of Instream Habitat in Hilton Creek* (COMB 1998) and the *Public Review Draft Santa Ynez River Fish Management Plan* (SYRTAC 1999) involves the construction of five cast-in-place concrete weirs and the emplacement of approximately ten boulders. This plan was developed based on qualitative field observations and has been modified based on further studies conducted in 1999.

In February 1999, the tentative improvement locations were selected based on water marks and channel geometry, and a hand level was used to estimate differential elevation and estimated backwater effects of the proposed structures. Using this information, a more detailed assessment was conducted between July-September of 1999, which involved surveying streambed profiles and cross-sections. A preliminary design was developed using the streambed profile and cross-section information, and this design was modified based on stage-discharge relationship data (at 3 cfs) collected in December 1999 and field observations made during a “ground-truthing” assessment. The preliminary design was presented to the Hilton Creek Work Group for review in February 2000, and the design was revised based on comments from the group members and observations made during the winter of 2000.

The final fish passage project design presented, incorporates the following considerations: ability to pass fish, constructability, site impacts, effects on flood stage, ability to pass sediment and debris, and overall stability of the structures and adjacent stream banks.

3.3.1.2 Project Design

The objective of the fish passage project is to improve fish passage through the existing migration impediment, which consists of a near-vertical 6-foot cascade and an approximately 140-foot long, confined bedrock chute situated immediately upstream of the cascade. The fish passage project design focuses on reducing the effective height of the cascade by modifying the streambed immediately upstream of the top of the cascade to create a resting pool and constructing a channel obstruction at the downstream control of the plunge pool to increase water depth in the pool. The high-flow velocities in the bedrock chute area will be addressed by constructing two large channel obstructions (or roughness elements) and five boulder-sized elements which will significantly reduce flow velocities and increase water depth in this area. The proposed project design element locations are presented in Figure 3-3, and detailed design drawings are provided in the memos entitled *Hilton Creek-Revised Fish Passage Project Design* dated May 3, 2000 and the *Hilton Creek-Design of Fish Passage Improvement Structures* dated May 26, 2000 (SYRTAC 2000c and 2000d).

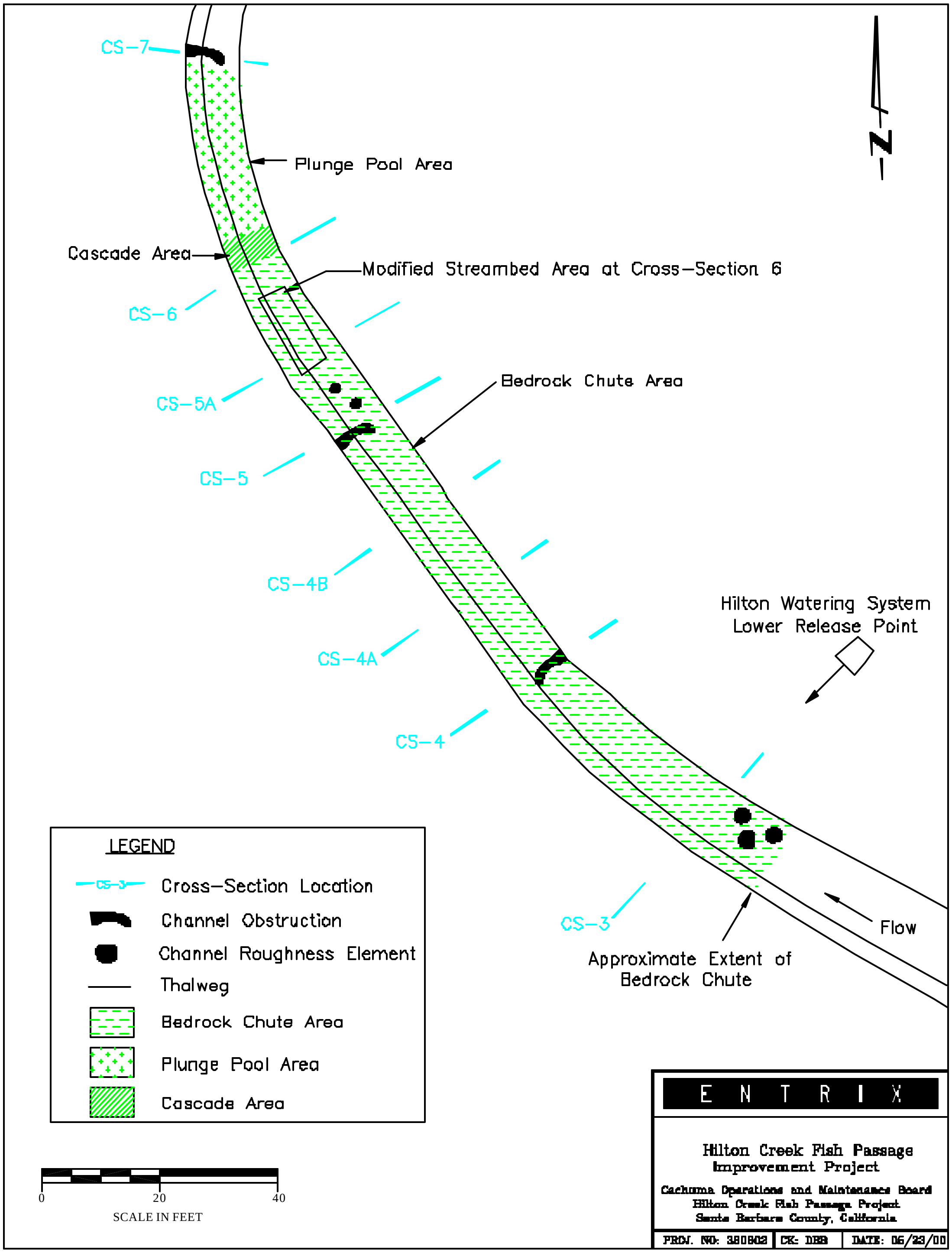

Figure 3-3 Conceptual Diagram of Fish Passage Enhancement to the Cascade/ Chute Impediment in Hilton Creek

Improved passage over the cascade will be achieved by modifying the streambed immediately upstream of the top of the cascade to create a pool in which the fish can rest and reducing the effective height of the cascade by constructing a channel obstruction at the downstream control of the plunge pool below the cascade. The revised design proposes to lower the thalweg 1 foot over a distance of approximately 15 feet upstream of the top of the cascade. The purpose of the lowered thalweg elevation is to create a pool at the top of the cascade while not increasing the height of the cascade. In order to prevent erosion of the downstream control of the pool, a cast-in-place concrete plug will be placed at the downstream edge of the pool. The proposed channel obstruction at the downstream control of the plunge pool will reduce the low-flow channel conveyance area by approximately 70% and the high water conveyance area by approximately 50%. Backwater effects from this roughness element will increase the water surface elevations up to 3 feet in the plunge pool for streamflows between 10 and 50 cfs. In general, the proposed improvements are anticipated to reduce the effective height of the cascade from 6 feet to 3 feet at streamflows above 20 cfs.

The proposed roughness elements within the bedrock chute will reduce the low-flow conveyance area of the channel from 67% to 90% and the high-flow conveyance area of the channel between 18% and 24%. The elements will also reduce flow velocities, increase surface water elevations, and provide areas of rest for the migrating steelhead. Additionally, the roughness elements will increase the thalweg elevations which will decrease the stream gradient and reduce flow velocities upstream of the structure.

The channel obstructions (or roughness elements) will consist of cast-in-place concrete structures securely anchored to the exposed bedrock channel, and will be constructed to resemble an exposed bedrock protrusion into the stream channel. The design of the roughness elements is specific to each proposed structure location. The roughness elements will be secured using re-enforcing steel rods which will be anchored into the

bedrock channel. Cast-in-place concrete is being proposed instead of natural rock boulders due to easier constructability, superior anchoring, greater control over size and shape, and lower installation cost. The final design was developed in consultation with fish passage experts from CDFG and NMFS and is consistent with the *CDFG California Stream Habitat Restoration Manual* and the requirements of the Endangered Species Act. Highway 154 Culvert

The Highway 154 Culvert is located approximately 4,000 feet upstream of the confluence of Hilton Creek with the Santa Ynez River. The culvert presents a physical barrier to migration due to the height of the outlet drop and a velocity barrier, since the smooth concrete lining of the culvert does not provide any velocity shadows at high flows, and sheet flow occurs under low-flow conditions. The fish passage modification project through the cascade and bedrock chute will improve access to stream habitat up to the Highway 154 Culvert. The objective of this project is to provide access to habitat upstream of the culvert.

SYRTAC working group members attended a field trip to the culvert where design considerations were presented and reviewed in detail. The proposed initial project design is being prepared by the engineers from the U.S. Fish and Wildlife Service (USFWS) and consists of constructing baffles in the culvert and a flow control structure downstream of the culvert outlet. The baffles are being designed to reduce flow velocities, provide velocity shadows, and create resting pools within the culvert at flows between 10 and 50 cfs. The purpose of the downstream flow control structure is to create a backwater effect which will reduce the height of the outlet drop. The project may also include the removal of debris at the upstream inlet of the culvert which may present an impediment.

The USFWS is preparing the project designs in consultation with CalTrans since the project would be constructed within the CalTrans easement which is approximately 35 to 40 feet on either side of Highway 154. Ongoing discussions with CalTrans, USFWS, CDFG, NMFS, and SYRTAC and/or Adaptive Management Committee scientists will determine the final project design.

3.4 RIPARIAN ENHANCEMENT

The objective of this project is to enhance riparian habitat along a 300-foot section above the cascade and bedrock chute, approximately 1,700 feet upstream from the confluence. This area consists of a broad flood plain which is fairly depauperate of riparian vegetation, and the streambed consists of cobble and gravel substrate. The riparian enhancement project would significantly improve the habitat along this section by providing a good canopy for protection and stabilizing the streambanks. It is likely that riparian growth in this reach will occur when the channel is watered by releases through the upper Hilton Creek release point and therefore a specific restoration effort may not be necessary. The Hilton Creek Work Group recommends that the riparian restoration effort not be implemented until the effect of watering this section of the creek on the riparian vegetation is known. The Adaptive Management Committee will be responsible for monitoring this section of Hilton Creek and making additional recommendations as necessary.

3.5 FISH RESCUE PLAN

While the supplemental water supply system will provide flow to Hilton Creek in most years, it may not be feasible to provide streamflow during the summer and fall in dry or critically dry years when the lake level falls to near 665 feet. Under natural conditions, over-summering fish are restricted to isolated pools as flows decline and are vulnerable to predation (by both fish and birds), desiccation, and exposure to elevated water temperatures. Therefore, in those years that supplemental streamflow cannot be provided, a fish rescue program may be implemented to move fish residing in Hilton Creek to more suitable habitat. In addition, should the Hilton Creek supplemental watering system fail and fish be at risk for stranding, a fish rescue would likely also be initiated. The decision to proceed with a fish rescue will be made in consultation with NMFS and CDFG.

Fish rescue operations have been successfully conducted in Hilton Creek in 1995 and 1998. In June 1998, approximately 831 young-of-the-year rainbow trout/steelhead and three adults were successfully moved from Hilton Creek to the mainstem Santa Ynez River above the Long Pool (676 fish) and San Miguelito Creek (153 young-of-the-year). During 1998, specific protocols were developed for determining when fish rescue operations would be initiated. These protocols include the Hilton Creek Fish Rescue Plan (Reclamation 1998) and the recommendations of the August 9, 1998 Hilton Creek Fish Rescue Assessment Report (Reclamation 1998b). Reporting requirements have also been established by NMFS that include (1) a specific description of the removal/relocation activities performed, (2) the number of steelhead removed from the project area and the number transferred to each relocation site, (3) the number of steelhead killed or injured during the removal/relocation, (4) a description of any problems encountered during the project or when implementing special conditions, (5) any effect of the project on steelhead that was not previously considered (NMFS 1998). These protocols may not be appropriate for all years, but 1998 provided a template for future coordination and cooperation between the Adaptive Management Committee, CDFG, NMFS, Reclamation, and USFWS. Future modifications must be approved by NMFS and documented in writing.

Hydrologic analysis indicates that a fish rescue operation would be necessary in approximately 2% (drought years) of all water years. During most of these years, it is likely that the river mouth would not open during the winter, thus, eliminating the potential for anadromous steelhead spawning in Hilton Creek. However, resident rainbow trout may still spawn, and juvenile steelhead from the previous year may still reside in the stream if winter flows do not cue them to emigrate.

The fish rescue plan for Hilton Creek is composed of two parts: (1) monitoring to determine when a fish rescue should be initiated, and (2) the capture and transfer of fish. These operations are described below.

3.5.1 MONITORING

Monitoring of flow levels and water temperatures within Hilton Creek will provide the primary information on when a fish rescue operation should be implemented. If flows are diminishing, or if water temperature is approaching stressful levels, then the project biologist will consult with the Adaptive Management Committee, CDFG, NMFS, Reclamation, and USFWS to decide if a fish rescue should be implemented. Once the need for a fish rescue has been identified, the creek will be monitored daily for signs of additional stress.

3.5.2 RESCUE AND RELOCATION

Fish rescue and predator control operations will be conducted as necessary in consultation with the Adaptive Management Committee, CDFG, NMFS, Reclamation, and USFWS. Fish rescue operations could also be conducted in other stream reaches in which conditions are threatening to rainbow trout/steelhead survival. Fish rescue operations in other areas will be conducted as necessary, based on the landowner's permission and in consultation with the resource agencies.

The most critical issue for a successful fish rescue operation is the availability of a receiving site with suitable habitat. If a fish rescue operation is necessary, the project biologist will investigate likely relocation areas and determine if the conditions (adequate streamflow, temperature, etc.) are favorable to steelhead. Once a suitable relocation area is identified, a survey of fry/juvenile density will be conducted to determine the availability of space for additional fish. Potential relocation sites include the Long Pool, portions of the mainstem, and several tributary reaches below Bradbury Dam.

After identifying an appropriate receiving site, the fish rescue will proceed using protocols similar to those used in 1998 in consultation with the Adaptive Management Committee, CDFG, NMFS, Reclamation, and USFWS. The fish rescue operations will be planned to commence in the morning to coincide with cooler water temperatures and will cease when water temperatures exceed 18°C. The operation will utilize seines and nets, and the fish will be placed in cool, well-aerated water. The temperature of the transport water will be adjusted to coincide with the receiving area water before release. If electrofishing is determined by the inter-agency discussions to be necessary, then the NMFS electrofishing policy will be adhered to.

To reduce the potential loss of relocated young-of-the-year rainbow trout/steelhead to predation, warmwater fish (largemouth, bass, smallmouth bass, and bullheads) may be removed from the receiving site if they are abundant. The warmwater fish can increase the mortality rates of young rainbow trout/steelhead both directly through predation, and indirectly by forcing young fish to occupy less suitable areas, which can impact growth rates, fitness, and exposure to other predators. Predator removal could also temporarily provide localized benefits to native fish in the mainstem pools, but over time these benefits would be reduced by recolonization from other areas (other stream reaches and/or Lake Cachuma). Predator removal would be most valuable as refuge pools become isolated during the summer.

Predators will be selectively removed from key pools using physical capture methods such as fyke nets (also called box traps) in larger pools and runs and seines in smaller pools. Captured native species will be returned to the stream and captured non-native species will be released in Lake Cachuma. The operations will be conducted under the supervision of a qualified fishery biologist. Predator removal activities have the potential to stress rainbow trout/ steelhead residing in the pool during the process. Steps to minimize the impact to these fish have been outlined in the Cachuma Project Biological Opinion (NMFS 2000) and are repeated from that document verbatim below:

> "A. Site inspections shall be performed prior to removal activities for the purpose of identifying the presence of endangered steelhead within the relocation area. Instream areas found to harbor steelhead shall be avoided during predator removal activities. Removal timing and techniques, and point of egress and ingress shall be modified to either avoid or minimize take of steelhead.
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> B. A fisheries biologist with training and expertise in steelhead biology shall supervise pre-action, removal, and post-removal surveys. The biologist shall be empowered to

halt those activities that may adversely affect steelhead, and recommend and implement avoidance measures.

C. The fishery biologist shall conduct a brief training session for all project personnel who are not fishery biologists familiar with steelhead before the action is implemented. The training session shall include a description of the steelhead and its habitat, general provisions and protections provided by the ESA, and the terms and conditions of this incidental take statement that will be implemented to minimize injury and mortality of steelhead.

D. Reclamation's fisheries biologist shall contact NMFS fisheries biologist Darren Brumback (562-980-4026) immediately if one or more steelhead are found dead or injured. If Darren Brumback is unavailable Reclamation shall immediately contact NMFS Protected Resources Division at 562-980-4020. If no one at Protected Resources is available, Reclamation shall immediately contact NMFS's Office of Law Enforcement at 562-980-4050. The purpose of the contact shall be to review the activities resulting in take and to determine if additional protective measures are required. Reclamation will need to supply the following information initially: The location of the carcass or injured specimen, the apparent or known cause of injury or death, and any information available regarding when the injury or death likely occurred.

E. Any steelhead captured, collected, or trapped shall be revived, if necessary, and immediately released without delay to either the capture location or a more suitable instream location. No steelhead body length or mass data shall be measured.

F. Reclamation shall provide a written report to the NMFS within 4 weeks following completion of the proposed action. One report shall be submitted to the NMFS for each year that the project action is implemented. The report shall include the number of steelhead observed, handled (captured, collected, trapped), killed and injured during the proposed action; the estimated size of individual steelhead observed, handled, injured, or killed; a map delineating the location(s) where steelhead were observed or handled; a description of any problem encountered during the project or when implementing terms and conditions; and, any effect of the proposed action on steelhead that was not previously considered."